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L'ETUDE ET L'EXPLOITATION DES PROCEDES GEROGES CLAUDE
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Title:

SETUP/WORKING PLAN AND PROCESS FOR CONSTRUCTION OF SEVERAL COMPLICATED INDUSTRIAL INSTALLATIONS

ABSTRACT:

The 'tool kit' or setup, in the following called a "working plan," for design/construction of a large number complicated industrial installations (1, 2) for the treatment of liquids consists of several sets (10, 15, 20, 25, 30, 35, 45, 50, 55, 60, 65, 70) of several functional modules (110, 115, 120, 125, 130, 135, 145, 150, 210, 215, 220, 225, 230, 235, 245, 260, 310, 315, 320, 325, 330, 335, 345, 350) each capable of performing an elementary operation. Each functional module consists of at least one entrance and at least one exit as well as one local administrative unit (ULG) of the functional module equipped with a communications interface (E/S). All functional modules of the same set (10, 15, 20, 25, 30, 35, 45, 50, 55, 60, 65, 70) perform the same elementary operation and are of standardized structure. The functional modules are adjusted to be functionally associated with each other in the installations. The setup also includes for each industrial installation (1, 2) a single central control unit (175, 275) adapted to control the functional modules of the industrial installation associated with it.

Description

The present invention concerns a setup kit for construction of a large number of complicated industrial installations for the treatment of liquids.

In numerous industrial production sites local means of production of gases having specific compositions and pressures are provided.

Therefore the items of production equipment which together make up the complicated industrial installation are installed at the site for treating the gas, generally extracted from air, and sending it to the user installation.

When the user installation must be supplied with several different liquids, the production installation positioned upstream must be relatively complicated in order to satisfy the needs. Two types of installation are presently proposed for the case of satisfying such a demand:

In a first design/solution the items of equipment, each of which is intended each for the production of one liquid are colocated in order to supply the required liquids to the user installation. Thus, for example, a compressed air central, an impure nitrogen generator and a pure nitrogen generator will be installed side by side.

This solution has the inconvenience of useless duplication of certain functions executed redundantly by several pieces of equipment. For example, it involves the functions of compression and of drying of the air which are necessary both in the compressed air center and in the nitrogen generators.

This duplication of functions results in excessive investment and operating costs. Moreover, in such installations the items of equipment intended for the production of each of the gases are frequently overdimensioned in order to be able to respond instantly to a variable demand.

A second solution consists of using a "tailor made" installation developed specifically to respond optimally to the needs of the user installation.

This solution leads to optimization of the production installation. However, it involves high research costs, and its industrial exploitation is made difficult due to the unique nature of the installation. Moreover, the further expansion of such an installation is difficult to manage if the demands of the consumer installation increase. Finally, such an installation is difficult to re-tool for performing a different function.

The invention has the purpose of proposing means for creating complicated industrial installations permitting, with a minimal investment, the creation of a broad range of industrial installations.

For this purpose the invention has as its subject a working plan or setup 'kit' for design and construction of several complicated industrial installations for the treatment of liquids characterized by the fact that it consists of:

- several sets, the functional modules each being capable of performing one elementary operation on at least one liquid of an industrial installation in which:
- each functional module consists of at least one entrance and at least one exit for the passage of a liquid as well as a local administrative unit for the functional modules which controls the functioning of the functional module for executing the associated elementary operation, said local administrative unit displaying a communications interface,
- all of the functional modules of the same set are adjusted to perform the same elementary operation on a liquid and are of standardized construction, so that the specific features of the entrances, the exits, and the communications interfaces of all functional modules of the same set are similar, and
- the functional modules are adapted to be functionally associated with each other through their entrances and exits in the industrial installation in order to assure successive elementary operations on the liquid,

which working plan also includes for each industrial installation a single control center designed to control the associated industrial installation by sending control commands to the local administrative units of the standard functional modules of the industrial installation via the communications interfaces linked to the central control unit by a communications network.

Depending on the specific modes of realization the working plan for construction displays one or more of the following characteristics:

- the local administrative unit of each standard functional module is adapted to sent messages of information to the central control unit of the installation, said messages of information being representative of the state of functioning of the functional module or the state of the liquid on which the functional module is operating,
- the central control unit of each installation has means for registering the requirements of the user devices linked to the exit of the installation through a data transfer network,
- it consists of a set of standard feed modules adapted to supply energy from part of the functional modules of each installation under the command of the control unit of the installation,
- it consists of a set of standard inspection/scanning modules to provide information on the fluid circulating in an installation and transmit said information to the central control unit of said installation, and
- it consists of a set of standard modules for the generation of electrical energy designed to assure the production of electricity from the energy supplied by other standard modules of the installation.

The invention also has as its subject a process for the structural design of several complicated industrial installations for the treatment of liquids characterized by the fact that it consists of steps including:

A) fabricating the sets, the functional modules each being capable of performing an elementary operation of an industrial installation in which:

- each functional module contains at least one entrance and one exit for the passage of a liquid as well as a local administrative unit of the functional module which governs the functioning of the functional module in executing the elementary operation associated with it, the local administrative unit consisting of a communications interface, and
- all of the functional modules of the same set are designed to perform the same elementary operation on a liquid and are of standardized construction, so that the specific features of the entrances, the exits and the interfaces of communication of all functional modules of the same assembly are similar,

B) fabricating for each industrial installation a central control unit designed to control the associated industrial installation by sending control commands to the local administrative units of each standard functional module of the installation through the communications interfaces connected to the central control unit by a communications network,

C) functionally associating, in each industrial installation, the functional modules with each other through their entrances and exits in order to assure the successive elementary operations on the liquid by each complicated industrial installation, and

D) installing in each industrial installation a central control unit connected to communications interfaces of all of the standard functional modules of the installation by a communications network.

The invention can be understood better by reading the following description which is given solely as an example and with reference to the drawings in which:

- Figure 1 is a schematic view of an example of a working plan for construction according to the invention whose functional modules are in two industrial installations or are located together, and
- Figure 2 is a schematic view of another industrial installation which can be fabricated with the aid of the working plan according to the invention.

The working plan for construction shown in Figure 1 consists of a large number of standard functional modules distributed as a function of their type among several sets. The functional modules of the same set are all designed to perform the same operation or elementary step leading to a principal transformation of a liquid.

The term elementary operation refers to a transformation of a given type capable of being conducted on a liquid such as, for example, the modification of its temperature, its pressure, its composition and/or all other variables of state.

In practice a transformation of a liquid is exerted by application of a principal function with which one or more related functions is associated to achieve the execution of the principal function.

For example, the principal function of a compression module is to increase the pressure of a gas, e.g., by the action of a screw. A related function in this case is the refrigeration of the gas which results from it. Another related function, for example, is filtration which is performed downstream from the screw of the compressor and which leads to a removal of the impurities from the gas.

The functional modules of the working plan of construction shown in Figure 1 are distributed in two installations for the production for gases, denoted by 1 and 2 and in a group of functional modules denoted by the general reference 3. Figure 2 shows another installation 4 realized from the working plan according to the invention.

On the figures the standard functional modules of the same set of functional modules are denoted by 3-digit reference numbers of which the first two digits are identical and representative of the set to which they pertain and of which the first number is equal to 1, 2 or 4 depending on the installation 1, 2 or 4 in which they are located or is equal to the number 3 if the functional modules are positioned in group 3.

The installation 1 is designed to produce, from atmospheric air, impure nitrogen, dry air, low pressure nitrogen and high pressure nitrogen. These gases are passed on to the consumer devices denoted 1A, 1B, 1C and 1D respectively.

The installation in Figure 1 consists of a standard compression module 110 at the entrance. The latter has 3 compressors mounted in parallel.

Like any functioning module of the working plan according to the invention the module 110 consists of a local administrative unit called ULG. The latter is suitable for controlling the functioning of the functional module in order to execute the associated elementary operation. In the present case the local administrative unit ULG is designed to administer locally the functioning of the three compressors installed in parallel.

The local administrative units ULG of all functional modules of the working plan according to the invention have a communications interface denoted by E/S which is capable of transmitting data from and to the corresponding functional modules.

Advantageously the local administrative unit ULG is composed of a computer of the PC type or a programmable automatic device which executes a suitable program.

At the exit from the compression module a drying module 115 is positioned which has two absorption bottles installed in parallel.

The exit from the drying module 115 feeds dry air directly to the consumer device 1B.

On a branch line feeding impure nitrogen the consumer equipment 1A a treatment module for air 120 and a permeation module 125 are arranged in series.

The air treatment module 120 consists of filters while the permeation module 125 consists of one or more selectively permeable membranes for nitrogen and for oxygen.

The exit from the drying module 115 is connected through a second branch line to several other functional modules which supply the consumer devices 1C and 1D with low and high pressure nitrogen.

On this branch line initially a desiccation-decarbonatation module is positioned 130. The latter has two adsorption bottles installed in parallel.

At the exit from the desiccation-decarbonatation module a distillation module 135 is provided as well as a control module 140. The distillation module 135 consists of a distillation column while the control module 140 has a set of pressure pickups.

The exit from the control module 140 is connected to the consumer apparatus 1C and supplies it with low pressure nitrogen.

The exit from the control module 140 is also connected to an pressurizing module 145 consisting of a supercompressor. The pressurizing module 145 supplies the consumer device 1D with high pressure nitrogen.

In addition the installation consists of storage module 150 connected to an entrance of the desiccation-decarbonatation module 130 for feeding the latter. The exits from the storage module 150 are also connected, on the one hand, to the distillation module 135 and on the other to the pressurizing module 145.

As indicated above, all functional modules of the working plan each consist of a local administrative unit ULG which assures the administration of the function performed by the associated functional module.

In each installation created from the working plan according to the invention the different functional modules are connected to the same central control unit 175 proper to the installation through the intermediacy of a communications network 180. This network, for example, is of the type ETHERNET, FIP, PROFIBUS or MODBUS. Each functional module connected to the network 180 by its communications interface E/S may therefore, on the one hand, receive control commands from the central control unit 175, and on the other, may send it information messages relative to its state of functioning.

The functioning of a given functional module is locally administered by the local administrative unit as a function of the control commands received from the central control unit.

In addition each user device 1A, 1B, 1C, 1D is connected to the central control unit 175 by a data transfer network 185 in order to communicate its requirements to it concerning the resource provided by the installation.

The central control unit 175 functions as the "band leader" by ordering the functioning of each functional modules of the installation as a function of the needs of the user devices and taking into account the information communicated by the functional modules, said information pertaining especially to its availability.

The control commands addressed by the central control unit consist essentially of values of orders that should be achieved at the exit from the functional module. For example, they may involve the flow rate of air for a compression module, the degree of hygrometry for a drying module or even the minimal composition of a given constituent for a permeation or distillation module.

The messages of information emitted by each functional module to the central control unit contain essentially data relative to the liquid on which the functional module is operating and data relative to the state or the requirements of the functional module.

The data pertaining to the state of the liquid is divided into intensive variables such as the temperature, the pressure or the composition of the liquid and extensive variables such as the volume or mass of the liquid treated.

The data relative to the state or the requirements of the functional modules pertain especially to the current state of functioning of the module and its future capacities for executing the operation for which it is designed. In addition these data also pertain to the requirements for resources, especially energy, required for the correct functioning of the functional module.

According to the invention, the standard functional modules of the same set are constructed in the standard manner so that the specific features of the entrances, the exits and the interfaces of communications E/S are similar.

Therefore, the functional modules of the same set are all capable of performing the same operation or elementary step on a liquid for the purpose of producing a change in the state of said liquid.

The modules are therefore all interchangeable among each other due to the fact of similarity of their entrances and exits. Moreover, they are capable of receiving control commands from any central control unit of an installation of their local administrative unit ULG.

The similarity between the entrances and exits of the different functional modules of the same set is enhanced by their functional similarities, i.e. to admit or evacuate a liquid of a given nature under specified conditions. However, the diameter of the entrances and exits or the connections which are arranged for them may be different, adaptation elements then being necessary when a given functional module is to be replaced by another functional module of the same set.

The installation 2 represented in Figure 1 is realized with the working plan of construction according to the invention. It is designed for supplying from atmospheric air to a consumer device 2A and impure nitrogen to a consumer device 2B.

According to the invention the installation 2 is realized from standard functional modules and a central control unit derived from the working plan of construction.

The installation 2 consists of an entrance, a compression module 210 mounted in series with a drying module 215. The exit from the drying module 215 is connected directly to the consumer device 2A by its dry air feed.

In addition a branch line assures the conveying of part of the dry air obtained at the exit from the drying module 215 to a pressurizing module 245. At the exit from the latter successively an air treatment module 220 and the permeation module 225 are positioned. The exit from the latter is connected to the consumer device 2B to be supplied with impure nitrogen.

Each of the functional modules of the installation 2 is connected to a central control unit 275 through a communications network 280. This connection is accomplished through the intermediacy of communications interfaces E/S of each functional module.

The consumer devices 2A and 2B are connected to the central control unit 275 by a data transfer network 285 permitting the consumer devices to transmit their requirements to the central control unit.

In addition, a supply module 290 is provided for feeding electrical energy from each of the functional modules of the installation 2. This supply module 290 consists, for example, of an electricity-generator group. It is equipped with a local administrative unit ULG designed to control the electricity- generating group. The local administrative unit ULG consists of a communications interface E/S connected to the network 280. Therefore the feed module

receives control commands from the central control unit 275 to determine its level of production as a function of the requirements of the functional modules being supplied.

The subassembly 3 contains different functional modules of each set. These functional modules are designated as before by a numerical reference of which the first digit is 3 and of which the second digits denote the set to which the functional module belongs.

Therefore the subassembly 3 consists of two standard compression modules 310. These compression modules display two compressors for one and one compressor for the other.

Likewise the subassembly 3 displays three drying modules 315, two air treatment modules 320, one permeation module 325, two desiccation-decarbonatation modules 330, two distillation modules 335, two control modules 340, two pressurizing modules 345 and two storage modules 350.

In addition the subassembly has two central control units 375.

In Figure 2 an installation for the co-generation of steam and electricity is shown which is realized from a working plan of construction according to the invention.

Therefore the functional modules used in this installation are standardized, and each is adapted to execute an elementary operation. The functional modules are controlled by a central control unit.

The installation shown in Figure 2 is adapted to produce electrical energy and steam from atmospheric air and natural gas at the same time. The electrical energy is supplied to a consumer device 4A and the steam is supplied to a consumer device 4B.

The installation 4 consists of a combustion module 455 displaying a combustion chamber whose functioning is controlled by the local administrative unit ULG belonging to the functional module in question.

The combustion module 455 displays an entrance for the introduction of natural gas and an entrance for introduction of an oxygen-containing gas formed from compressed air. These inputs supply the boiler for the establishment of a flame.

The installation displays a compression module 445 which receives at the entrance atmospheric air and supplies the combustion module 455 with compressed air from its exit.

The exit from the combustion module 455 is connected to a module for expansion 460 displaying a gas turbine. The gas turbine of the expansion module 460 is connected mechanically to a module for the production of electrical energy 465 through a shaft 462. The module for production of electrical energy 465 has an alternator driven by the shaft 462.

Therefore through the action of the smoke gases coming from the combustion module 450 the turbine of the expansion module 460 drives the compressor of the compression module 455 and the alternator of the electrical energy module 465.

The exit from the expansion module 460 is connected to an entrance of a steam production module 470. The latter has a coil installed in a boiler. The coil receives water at the entrance and produces steam at the exit. For vaporization of water under the influence of the heat of a flame, at its entrance the boiler receives natural gas, air and the combustion residues coming from the combustion module 455 after they have passed through the expansion module 460.

As in any installation realized from the working drawing according to the invention the installation 4 displays a central control unit 475 connected to a network 460 by communications interfaces E/S of the local administrative units of each of the functional modules.

The user devices 4A and 4B are linked to the central control unit 475 by a network 480 to indicate to it the requirements for resources produced at the exit from the modules 465 and 470 respectively.

As in any installation realized from the work plan according to the invention, the installation is administered by a central control unit 475 which sends control commands to each of the functional modules and receives from them information messages.

The standardization of the entrances, the exits and the interfaces of communication permits a reduction in the overall cost of realization and operation of the several installations for the treatment of liquids while still satisfying the requirements of the consumer devices located downstream.

The presence in each functional module of a local administrative unit assuring the administration of the functioning of the module via the control commands received from the central control unit permits a simple and rapid configuration of the installation, the central control unit alone being conFigured and programmed to respond to the requirements of the user devices.

The installations described are designed for the treatment essentially of gases. However, the working plan according to the invention may have functional modules which permit the treatment of liquids or powder-like material.

Moreover, the installation described here permits the administration of banks of functional modules thanks to the feedback of the states of the latter to the central control unit.

A working plan for construction as described here is especially useful for the treatment of gases, especially for the separation of gases from air.

Claims

1. Working plan or setup 'tool kit' for construction of several complicated industrial installations (1,2,4) for the treatment of liquids characterized by the fact that it consists of:

- several sets (10, 15, 20, 25, 30, 35, 45, 50, 55, 60, 65, 70) of several functional modules (110, 115, 120, 125, 130, 135, 145, 150, 210, 215, 220, 225, 230, 235, 245, 260, 310,

315, 320, 325, 330, 335, 345, 350, 445, 455, 460, 465, 470) each capable of performing an elementary physical operation on at least one liquid of an industrial installation in which:

- each functional module consists of at least one entrance and at least one exit for the passage of a liquid as well as a local administrative unit for the functional modules which controls the functioning of the functional module for executing the associated elementary operation, said local administrative unit (ULG) displaying a communications interface (E/S),
- all of the functional modules of the same set (10, 15, 20, 25, 30, 35, 45, 50, 55, 60, 65, 70) perform the same elementary operation on a liquid and are of standardized construction, so that the specific features of the entrances, the exits, and the communications interfaces of all functional modules of the same set are similar, and
- the functional modules are designed to be functionally associated with each other through their entrances and exits in the industrial installation in order to assure successive elementary operations on the liquid,

which working plan also includes for each industrial installation (1,2,4) a single control center (175, 275, 475) designed to control the associated industrial installation (1, 2, 4) by sending control commands to the local administrative units (ULG) of the standard functional modules of the industrial installation via the communications interfaces (E/S) linked to the central control unit (175, 275, 475) by a communications network (180, 280, 480).

2. Working plan as in claim 1 characterized by the fact that the local administrative unit (ULG) for each functional module is adapted to address the central control unit (175, 275, 475)

of the installation, messages of information representative of the state of functioning of the functional module or the state of the liquid on which the functional module is operating.

3. Working diagram as in claims 1 or 2 characterized by the fact that the central control unit (175, 275, 475) of each installation (1, 2, 4) has means for registering the requirements of the user devices (1A, 1B, 1C, 1D, 2A, 2B, 4A, 4B) connected to the exit from the installation through a data transfer network (185, 285, 485).

4. Working plan as in any of the foregoing claims characterized by the fact that it consists of a set of standard feed modules (290) modified to assure the supply of energy from part of the functional modules of each installation under the control of the control unit (275) of the installation.

5. Working plan as in any of the foregoing claims characterized by the fact that it consists of a set of standard control modules (140, 340) modified to provide information on the fluid circulating in an installation and of transmitting said information to the central control unit (175) of said installation.

6. Working plan as in any of the foregoing claims characterized by the fact that it consists of a set of standard modules for the generation of electrical energy (465) which are adapted to assure the production of electricity from energy furnished by the other standard modules (460) of the installation.

7. Process for construction of several complicated industrial installations (1, 2, 4) for the treatment of liquids characterized by the fact that it consists of steps which include:

A) fabricating the sets (10, 15, 20, 25, 30, 35, 45, 50, 55, 60, 65, 70), of several functional modules (110, 115, 120, 125, 130, 135, 145, 150, 210, 215, 220, 225, 230, 235, 245, 260, 310, 315, 320, 325, 330, 335, 345, 350, 445, 455, 460, 465, 470), said the functional

modules each being capable of performing an elementary operation of an industrial installation in which:

- each functional module displays at least one entrance and one exit for the passage of a liquid as well as a local administrative unit (ULG) of the functional module which governs the functioning of the functional module in executing the elementary operation associated with it, the local administrative unit (ULG) consisting of a communications interface (E/S), and
- all of the functional modules of the same set (10, 15, 20, 25, 30, 35, 45, 50, 55, 60, 65, 70) are designed to perform the same elementary operation on a liquid and are of standardized construction, so that the specific features of the entrances, the exits and the communications interfaces (E/S) of all functional modules of the same assembly are similar,

B) fabricating for each industrial installation a central control unit (175, 275, 475) designed to control the associated industrial installation by sending control commands to the local administrative units (ULG) of each standard functional module of the installation through the communications interfaces (E/S) connected to the central control unit (175, 275, 475) by a communications network (180, 280, 480),

C) functionally associating, in each industrial installation (1,2,4), the functional modules with each other through their entrances and exits in order to assure the successive elementary operations on the liquid by each complicated industrial installation, and

D) installing in each industrial installation (1, 2, 4) a central control unit (175, 275, 475) connected to communications interfaces (E/S) of all of the standard functional modules of the installation by a communications network (180, 280, 480).

Two pages of drawings appended

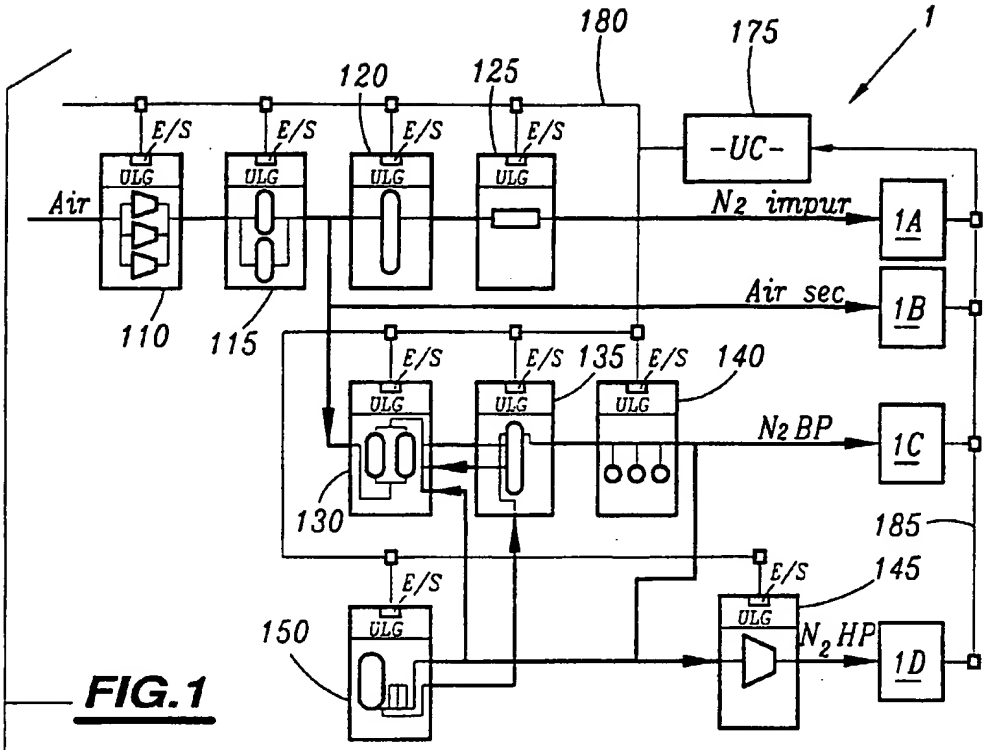
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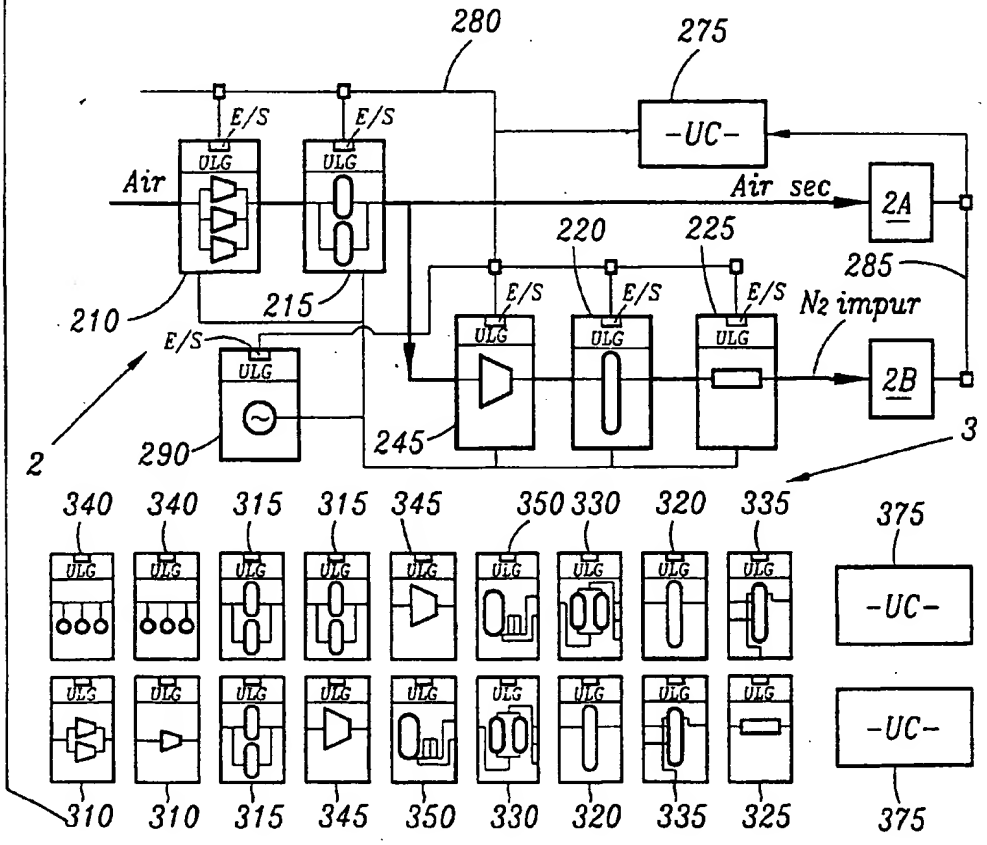
FIG.1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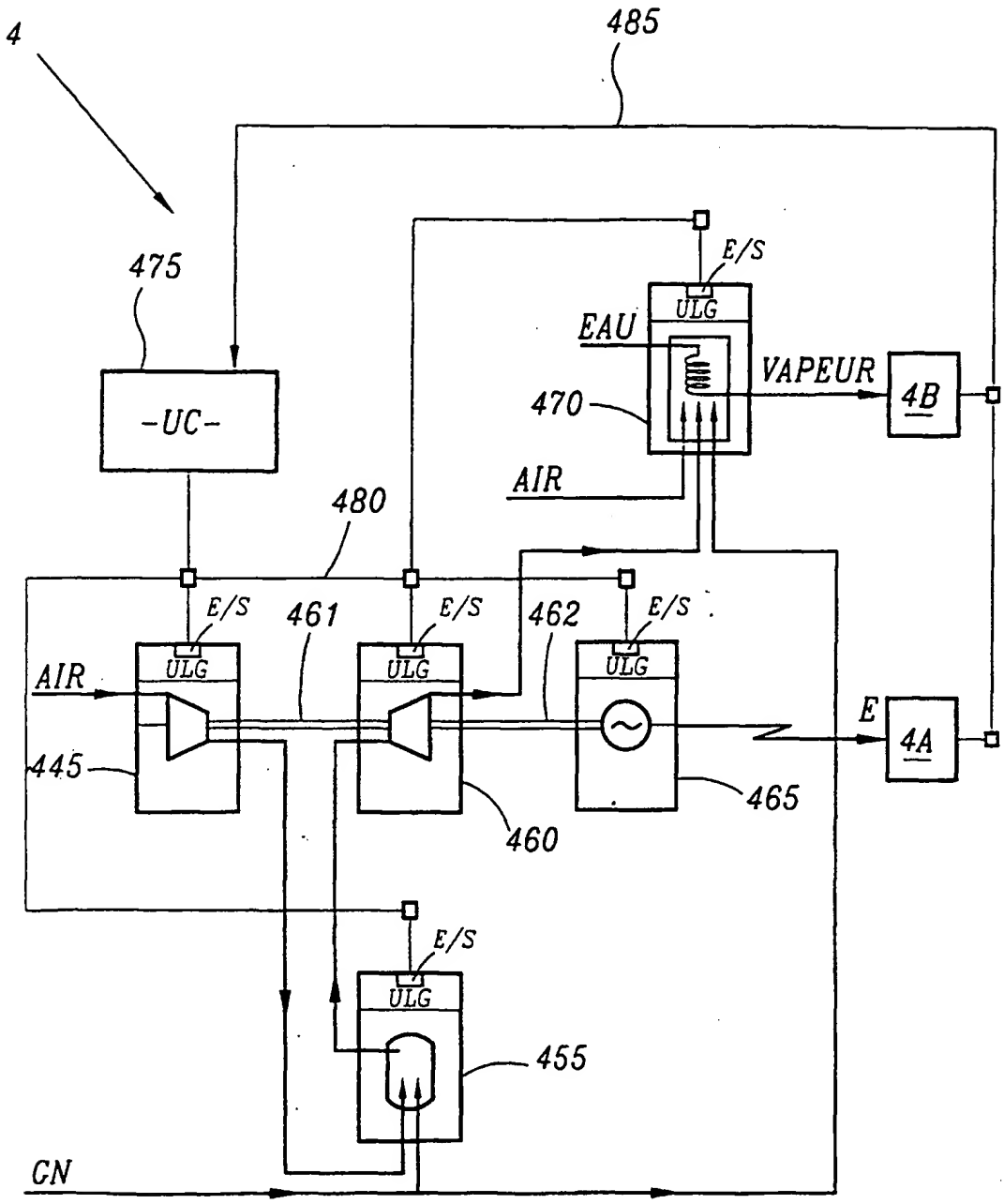
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FIG.2